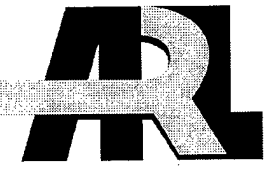
Army Research Laboratory



A Proposed Software Design for Weather Effects on Artillery (WEA)

by
Stephen Kirby
David Knapp

Computational and Informational Sciences Directorate
Battlefield Environment Division

ARL-TN-127 April 2001

Approved for public release; distribution unlimited.

NOTICES

Disclaimers

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Citation of manufacturers' or trade names does not constitute an official endorsement or approval of the use thereof.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave Blank*)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	April 2001	Final Technical Note

4. TITLE AND SUBTITLE
A Proposed Software Design for Weather Effects on Artillery (WEA)

5. FUNDING NUMBERS

6. AUTHOR(S)

S. Kirby
D. Knapp

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Research Laboratory
Computational & Information Sciences Directorate
Battlefield Environment Division
ATTN: AMSRL-CI-EA
White Sands Missile Range, NM 88002-5501

8. PERFORMING ORGANIZATION REPORT NUMBER

ARL-TN-127

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Research Laboratory
2800 Powder Mill Road
Adelphi, MD 20783-1145

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

ARL-TN-127

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

A

13. ABSTRACT (Maximum 200 words)

Work has begun on a software suite that will automate the extraction of weather impacts information on artillery. By combining the information provided by the Battlescale Forecast Model and the Atmospheric Sounding Program with a rule base of thresholds for artillery systems, the user will be able to see either a text display of the effectiveness of a given artillery system or a map overlay demarcating the degree of effectiveness of a particular artillery system. This concept has been developed in software before as the Integrated Weather Effects Decision Aid (IWEDA); however, the application was for a much broader array of military systems as well as personnel. IWEDA has a rule for "artillery"; however, it is generic. Weather Effects on Artillery (WEA) will focus on three specific artillery systems initially: Sense & Destroy Armor (SADARM), Brilliant Anti-Tank (BAT), and Multiple-Launch Rocket System (MLRS). Included in the rule base will be systems used in tandem with artillery such as laser designators. In the alpha version of WEA, 26 rules will be instituted that will reference meteorological parameters including target-area winds, cloud base, precipitation type, winds aloft, turbulence, temperature. IWEDA uses the Joint Mapping Toolkit (JMTK) for its map overlays. WEA will use the Geographic Resources Analysis Support System (GRASS), a very mature geographic information system for the overlay of contours delineating artillery effectiveness information.

14. SUBJECT TERMS

artillery meteorology, Battlescale Forecast Model, Atmospheric Sounding Program, Geographic Information System, weather thresholds

15. NUMBER OF PAGES
22

16. PRICE CODE

17. SECURITY CLASSIFICATION OF THIS REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

Contents

Figures

1. Introduction

In military operations, precise knowledge of the weather and how it will affect operations is critical. Thus, considerable time and effort has been applied to defining the operational weather-related thresholds for both personnel and systems. Artillery is one category of weapon systems in which weather thresholds have been delineated due to the experiences of both equipment testers and military gunners. To address a current Science and Technology Objective, "Deep Attack and Indirect Fire Meteorological Improvement," work is beginning on a software system that will automate the quantification of how a given weather situation will affect a particular artillery or artillery-related system.

This software concept is not new; however, the specific systems that are addressed are new. At the U.S. Army Research Laboratory, White Sands Missile Range, NM, a software system that addresses this type of problem, called the Integrated Weather Effects Decision Aid (IWEDA), has been developed and fielded. IWEDA has a large rule base for how various weather parameters will affect a myriad of systems including aircraft and missiles; entities such as personnel; and nuclear, biological, and chemical constituents. [1]

IWEDA uses weather information from the Battlescale Forecast Model (BFM) and the Atmospheric Sounding Program (ASP) as input and ultimately derives a matrix of systems (and in some cases subsystems). A user can click on one of these to determine whether meteorological (met) conditions for the application of that particular entity have been deemed "favorable", "marginal", or "unfavorable". Another product of IWEDA is a map overlay, which displays color contours demarcating areas. If met information is available, the map overlay shows favorable/marginal/unfavorable areas that, for example, personnel could operate in (temperature effects), helicopters could operate in (wind speed, icing, turbulence effects), etc.

2. Proposed Design

2.1 Building an Artillery-Tailored Decision-Aid Program

IWEDA is a proven system so why not use it as the foundation for building an artillery-tailored decision-aid program?

One important reason is that IWEDA was created as a complement to the Integrated Meteorological System (IMETS), which maintains a large database of current met values for several areas such as the continental United States, Southeast Asia, and a theater in Europe. Before the IWEDA rules can be fired, a 4-dimension grid of met data tying all of the key thresholds to a particular point in space and time must be created. Thus, in the case of IWEDA, this means numerous system query language (sql) calls to the IMETS Informix database. For this proposed Weather Effects on Artillery (WEA) software, the preprocessing of met data will instead involve manipulation of flat files of met data.

Secondly, the IWEDA is tied to IMETS; therefore, it uses the Joint Mapping Toolkit (JMTK) software for all of its map overlays. Adopting JMTK for WEA would require a reliance on government contractors in charge of JMTK in case any bugs or other problems were encountered. Instead, we propose the adoption of a very mature, freely available geographic information system (GIS) called the Geographic Resources Analysis and Support System (GRASS) Version 5.06 with which both raster and vector graphics can easily be depicted.

Lastly, although IWEDA has a generic "artillery" entity (from Annex D, METOC Impacts on Operations) in its rule base, it does not focus on the specific artillery systems that this software will, namely, Sense & Destroy Armor (SADARM), Brilliant Anti-Tank (BAT), and Multiple-Launch Rocket System (MLRS). Also to be included in the WEA rule base are systems pertinent to artillery such as laser designators, Unmanned Aerial Vehicle (UAV), Remotely Piloted Vehicle (RPV), and drones. [2]

2.2 Hardware/Software

The proposed platform is an Intel system running Linux. The interface will be written in Java (the Java Development Kit [jdk1.3] runs under Linux). Java is able to invoke "native" code such as C/C++. GRASS is Unix-based as well.

BFM will provide gridded wind direction and speed, temperature, and moisture information. ASP uses BFM (and/or another mesoscale model) data as input and derives parameters that can affect artillery such as precipitation type and rate, visibility, turbulence, icing, and cloud layers and ceiling.

A WEA preprocessor will first take the BFM and ASP flat files and extract all the thresholds relevant to the database of artillery systems. In the "alpha" version of WEA, a rule base for six artillery/artillery-related systems will be written. The language for the preprocessor implementation has not been determined. C/C++ will be an option since, as described earlier, Java can call native code.

A rule base encoding of all of the thresholds for each system must also be written. The alpha version of WEA will have 26 rules. For example, SADARM is sensitive to target area winds; MLRS is functional only within a strict temperature range; and UAV, RPV, and drones will be affected by turbulence. The temperature and target area wind information will come from BFM output while the turbulence information will be available in the ASP output.

Once the preprocessing for weather impacts on the artillery systems has been completed, then the information determining if a system is go/marginal/no-go and for what geographic areas has to be passed back to GRASS. This will require system calls to GRASS where the appropriate values to draw contours are passed.

A few samples of the menu driven WEA graphical user interface (GUI) are shown in figures 1 through 3.

From the Program button, the user can learn more about Computer Assisted Artillery Meteorology (CAAM), BFM, or WEA or can exit the program (figure 1). From the Computer Assisted Artillery Meteorology Battlescale Forecast Model (CAAM BFM) button, the user can select "Start," which will pop-up the "java-caam" GUI and allow the user to set up and do a CAAM BFM run. The "Preprocessor" menu item allows the user to kick off this module which will determine how the actual met correlates to the rule base of thresholds for each point in the area of interest (AOI) (as determined by the BFM run), for each system. Text will be periodically displayed indicating progress of the Preprocessor program as seen in figure 2.

The "Impacts" menu item has a submenu of six artillery systems/systems related to artillery. When the user clicks on one of them, a text box will be displayed with information on whether conditions are favorable/marginal/unfavorable for the use of that system. If marginal/unfavorable conditions are listed, the met conditions that caused them will be listed as well (figure 3). Finally, the "Map Overlay" menu will have these same six systems listed. Clicking on any one of them will pop-up a GRASS-based view of either a map or terrain data with color contours illustrating the favorable/marginal/unfavorable areas for a particular system.

Figure 1. Information from the "About CAAM BFM" submenu under "Program" menu.

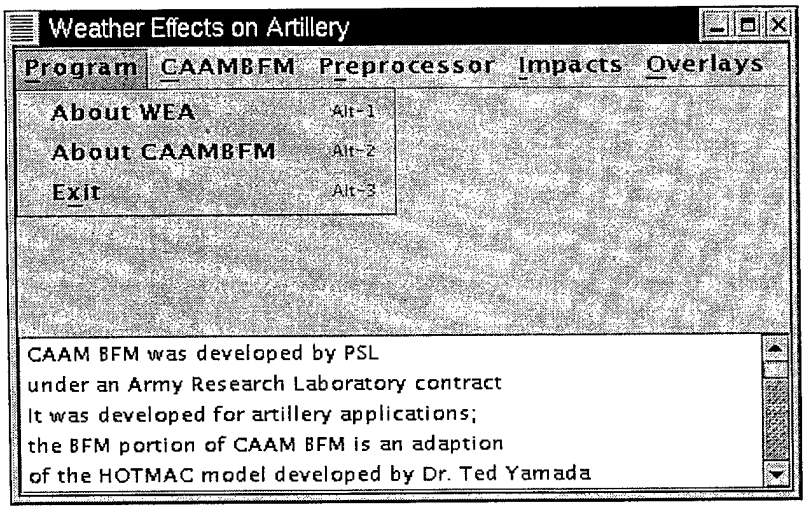
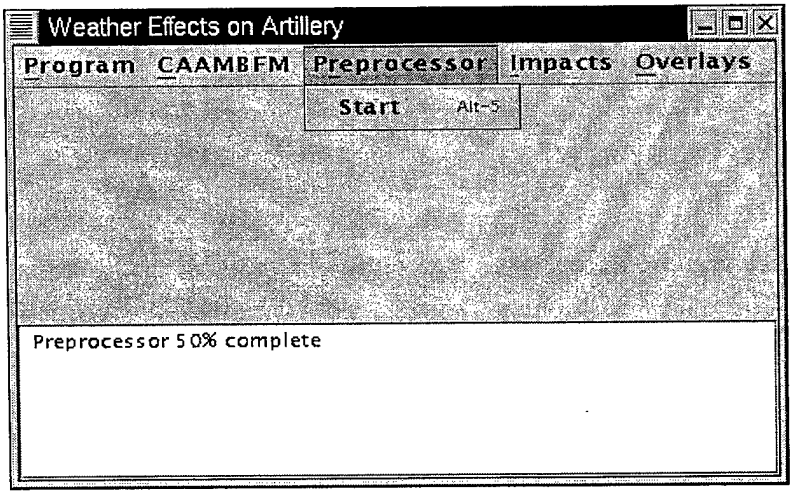
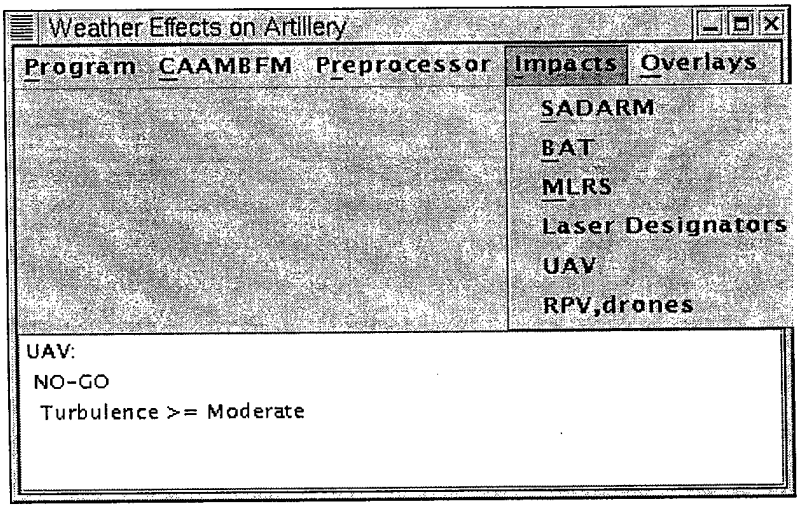


Figure 2. When starting the Preprocessor, the program's progress will be tracked in the text window.



When one of the six "Impacts" submenu items is chosen, a text description will be given as to whether conditions are favorable/marginal/unfavorable for use of that system. Figure 3 is an example of a submenu.

Figure 3. An example when UAV is selected.



Reference

1. Sauter, D. P. "An Interactive Information and Processing System to Assist the Military with Command and Control Decision Making", *Proceedings of the 16th International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography and Hydrology*, Long Beach, CA, pp. 279-282, 2000. (UNCLASSIFIED)
2. *Annex D. METOC Impacts on Operations, Joint Meteorology and Oceanography (METOC) Handbook*, 1999. (UNCLASSIFIED)

Acronyms

AOI	area of interest
ASP	Atmospheric Sounding Program
BAT	Brilliant Anti-Tank
BFM	Battlescale Forecast Model
CAAM	Computer Assisted Artillery Meteorology
CAAM BFM	Computer Assisted Artillery Meteorology Battlescale Forecast Model
GIS	geographic information system
GRASS	Geographic Resources Analysis and Support System
GUI	Graphical User Interface
IMETS	Integrated Meteorological System
IWEDA	Integrated Weather Effects Decision Aid
JMTK	Joint Mapping Toolkit
MLRS	Multiple-Launch Rocket System
RPV	Remotely Piloted Vehicle
SADARM	Sense & Destroy Armament/Armor
sql	system query language
UAV	Unmanned Aerial Vehicle
WEA	Weather Effects on Artillery

Distribution

	Copies
NASA MARSHALL SPACE FLT CTR ATMOSPHERIC SCIENCES DIV SDO1 ATTN DR FICHTL HUNTSVILLE AL 35802	1
NASA SPACE FLT CTR ATMOSPHERIC SCIENCES DIV CODE ED 41 1 HUNTSVILLE AL 35812	1
US ARMY MISSILE CMND AMSMI RD AS SS ATTN MR H F ANDERSON REDSTONE ARSENAL AL 35898-5253	1
US ARMY MISSILE CMND AMSMI RD AS SS ATTN MR B WILLIAMS REDSTONE ARSENAL AL 35898-5253	1
US ARMY MISSILE CMND AMSMI RD DE SE ATTN MR GORDON LILL JR REDSTONE ARSENAL AL 35898-5245	1
US ARMY MISSILE CMND REDSTONE SCI INFO CTR AMSMI RD CS R DOC REDSTONE ARSENAL AL 35898-5241	1
US ARMY MISSILE CMND AMSMI REDSTONE ARSENAL AL 35898-5253	1
PACIFIC MISSILE TEST CTR GEOPHYSICS DIV ATTN CODE 3250 POINT MUGU CA 93042-5000	1
ATMOSPHERIC PROPAGATION BRANCH SPAWARSYSCEN SAN DIEGO D858 49170 PROPAGATION PATH SAN DIEGO CA 92152-7385	1
METEOROLOGIST IN CHARGE KWAJALEIN MISSILE RANGE PO BOX 67 APO SAN FRANCISCO CA 96555	1

NCAR LIBRARY SERIALS 1
NATL CTR FOR ATMOS RSCH
PO BOX 3000
BOULDER CO 80307-3000

HEADQUARTERS DEPT OF ARMY 1
DAMI POI
ATTN LEE PAGE
WASHINGTON DC 20310-1067

US ARMY INFANTRY 1
ATSH CD CS OR
ATTN DR E DUTOIT
FT BENNING GA 30905-5090

HQ AFWA/DNX 1
106 PEACEKEEPER DR STE 2N3
OFFUTT AFB NE 68113-4039

PHILLIPS LABORATORY 1
PL LYP
ATTN MR CHISHOLM
HANSCOM AFB MA 01731-5000

PHILLIPS LABORATORY 1
PL LYP 3
HANSCOM AFB MA 01731-5000

AFRL/VSBL 1
29 RANDOLPH RD
HANSCOM AFB MA 01731

ARL CHEMICAL BIOLOGY 1
NUC EFFECTS DIV
AMSRL SL CO
APG MD 21010-5423

US ARMY MATERIEL SYST 1
ANALYSIS ACTIVITY
AMSXY
APG MD 21005-5071

ARMY RESEARCH LABORATORY 1
AMSRL D
2800 POWDER MILL ROAD
ADELPHI MD 20783-1145

ARMY RESEARCH LABORATORY 1
AMSRL OP CI SD TL
2800 POWDER MILL ROAD
ADELPHI MD 20783-1145

ARMY RESEARCH LABORATORY 1
AMSRL CI LL
ADELPHI MD 20783-1197

ARMY RESEARCH LABORATORY 1
AMSRL SS SH
ATTN DR SZTANKAY
2800 POWDER MILL ROAD
ADELPHI MD 20783-1145

ARMY RESEARCH LABORATORY 1
AMSRL CI
ATTN J GANTT
2800 POWDER MILL ROAD
ADELPHI MD 20783-1197

ARMY RESEARCH LABORATORY 1
AMSRL
2800 POWDER MILL ROAD
ADELPHI MD 20783-1145

NATIONAL SECURITY AGCY W21 1
ATTN DR LONGBOTHUM
9800 SAVAGE ROAD
FT GEORGE G MEADE MD 20755-6000

US ARMY RSRC OFC 1
ATTN AMXRO GS DR BACH
PO BOX 12211
RTP NC 27009

DR JERRY DAVIS 1
NCSU
PO BOX 8208
RALEIGH NC 27650-8208

US ARMY CECRL 1
CECRL GP
ATTN DR DETSCH
HANOVER NH 03755-1290

US ARMY ARDEC 1
SMCAR IMI I BLDG 59
DOVER NJ 07806-5000

ARMY DUGWAY PROVING GRD 1
STEDP MT DA L 3
DUGWAY UT 84022-5000

ARMY DUGWAY PROVING GRD 1
STEDP MT M
ATTN MR BOWERS
DUGWAY UT 84022-5000

DEPT OF THE AIR FORCE 1
OL A 2D WEATHER SQUAD MAC
HOLLOMAN AFB NM 88330-5000

PL WE 1
KIRTLAND AFB NM 87118-6008

USAF ROME LAB TECH 1
CORRIDOR W STE 262 RL SUL
26 ELECTR PKWY BLD 106
GRIFFISS AFB NY 13441-4514

AFMC DOW 1
WRIGHT PATTERSON AFB OH 45433-5000

US ARMY FIELD ARTILLERY SCHOOL 1
ATSF TSM TA
FT SILL OK 73503-5600

CM 1
220 7TH STREET NE
CHARLOTTESVILLE VA 22902-5396

NAVAL SURFACE WEAPONS CTR 1
CODE G63
DAHLGREN VA 22448-5000

US ARMY OEC 1
CSTE EFS
PARK CENTER IV
4501 FORD AVE
ALEXANDRIA VA 22302-1458

US ARMY CORPS OF ENGRS 1
ENGR TOPOGRAPHICS LAB
ETL GS LB
FT BELVOIR VA 22060

US ARMY TOPO ENGR CTR 1
CETEC ZC 1
FT BELVOIR VA 22060-5546

SCI AND TECHNOLOGY 1
101 RESEARCH DRIVE
HAMPTON VA 23666-1340

US ARMY NUCLEAR CML AGCY 1
MONA ZB BLDG 2073
SPRINGFIELD VA 22150-3198

USATRADOC 1
ATCD FA
FT MONROE VA 23651-5170

ATRC WSS R 1
WSMR NM 88002-5502

ARMY RESEARCH LABORATORY 1
AMSRL CI E
COMP & INFO SCI DIR
WSMR NM 88002-5501

DTIC 8725 JOHN J KINGMAN RD STE 0944 FT BELVOIR VA 22060-6218	1
AMSMI REDSTONE ARSENAL AL 35898-5243	1
US ARMY DUGWAY PROVING GRD STEDP3 DUGWAY UT 84022-5000	1
USTRADOC ATCD FA FT MONROE VA 23651-5170	1
WSMR TECH LIBRARY BR STEWS IM IT WSMR NM 88002	1
ARMY RESEARCH LABORATORY 2800 POWDER MILL RD ADELPHI MD 20783-1197	1
INFORMATION & INTELLIGENCE WARFARE DIRECTORATE ATTN AMSEL RD IW IP FORT MONMOUTH NJ 07703-5211	1
ARMY RESEARCH LABORATORY AMSRL CI EA ATTN S KIRBY WSMR, NM 88002-5502	2
Record copy	1
TOTAL	57